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Homma et al.

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(54) **FUEL SUPPLY DEVICE**

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H01R 13/40 (2006.01)

(52) **U.S. Cl.** **439/589**; 439/271; 439/281; 439/891

(58) **Field of Classification Search** 439/271, 439/281, 587, 589, 692, 891
See application file for complete search history.

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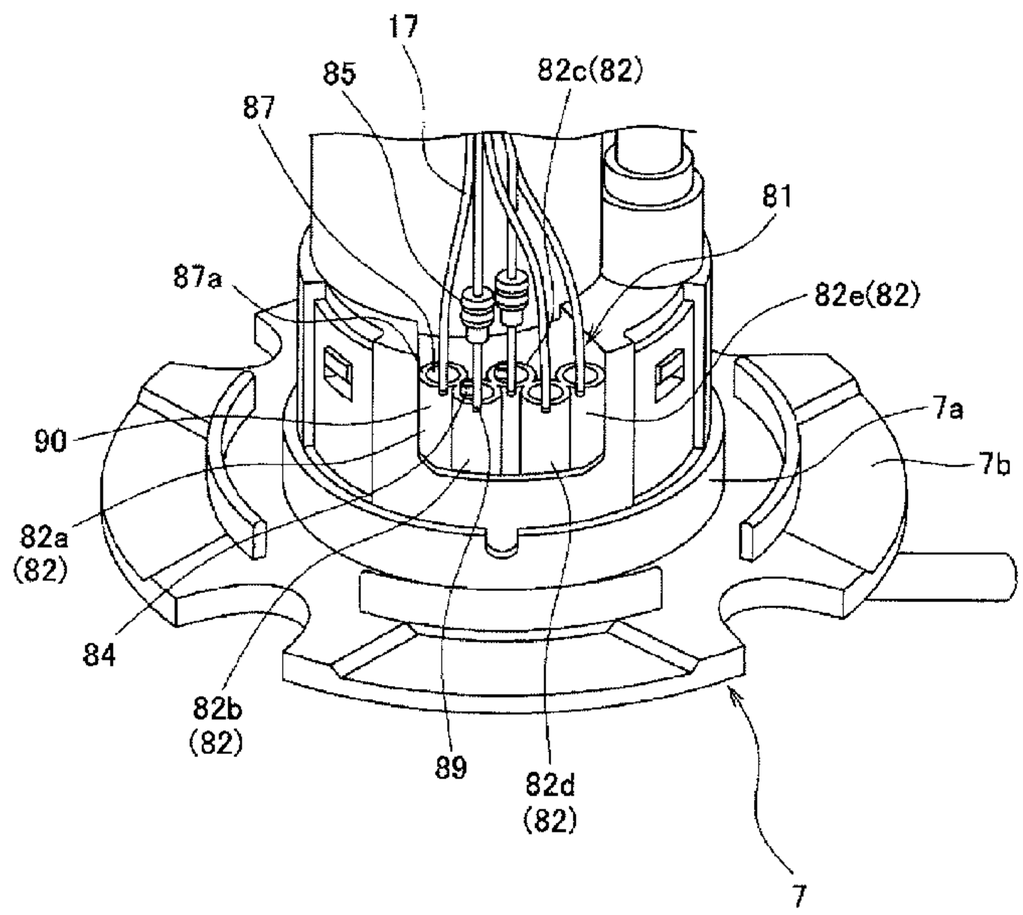
(57) **ABSTRACT**

Male terminals are respectively provided in terminal attachment portions formed on a flange unit. Female terminals and grommets are provided for a harness. A seal lip portion to be fitted into each of the terminal attachment portions is formed on each of the grommets. In the cylindrical terminal attachment portions the male terminals are individually accommodated while being electrically insulated from each other. The terminal attachment portions are arranged alternately in two rows so that a line segment obtained by connecting the respective centers of openings of the terminal attachment portions is a polygonal line. The openings are arranged to form the Olympic symbol. At a fore-end of each of the terminal attachment portions, slits are provided. Owing to the slits, the opening is likely to be enlarged when the rubber grommet is inserted therethrough. As a result, the placement of the rubber grommet is facilitated.

8 Claims, 8 Drawing Sheets



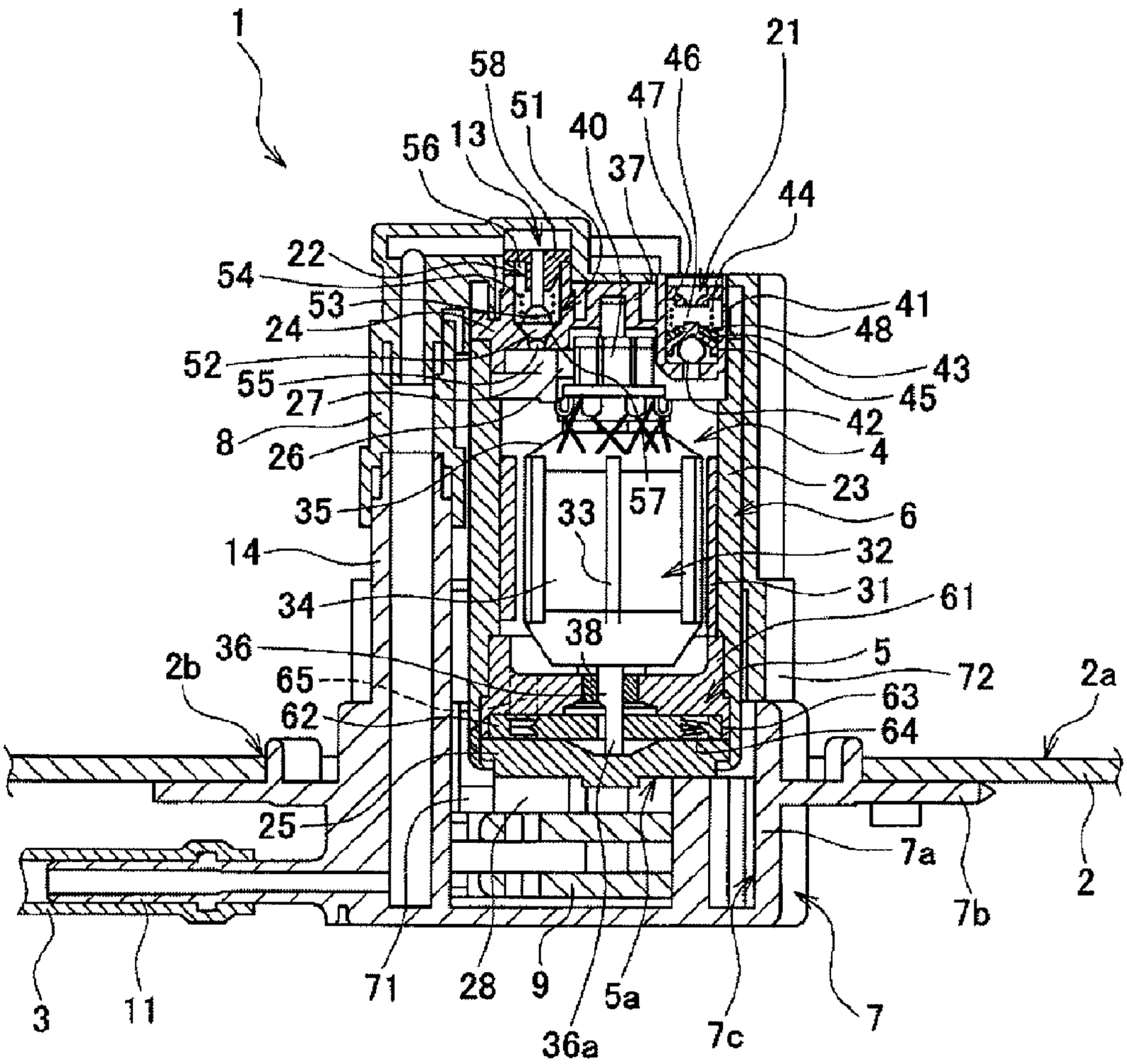

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FIG. 1

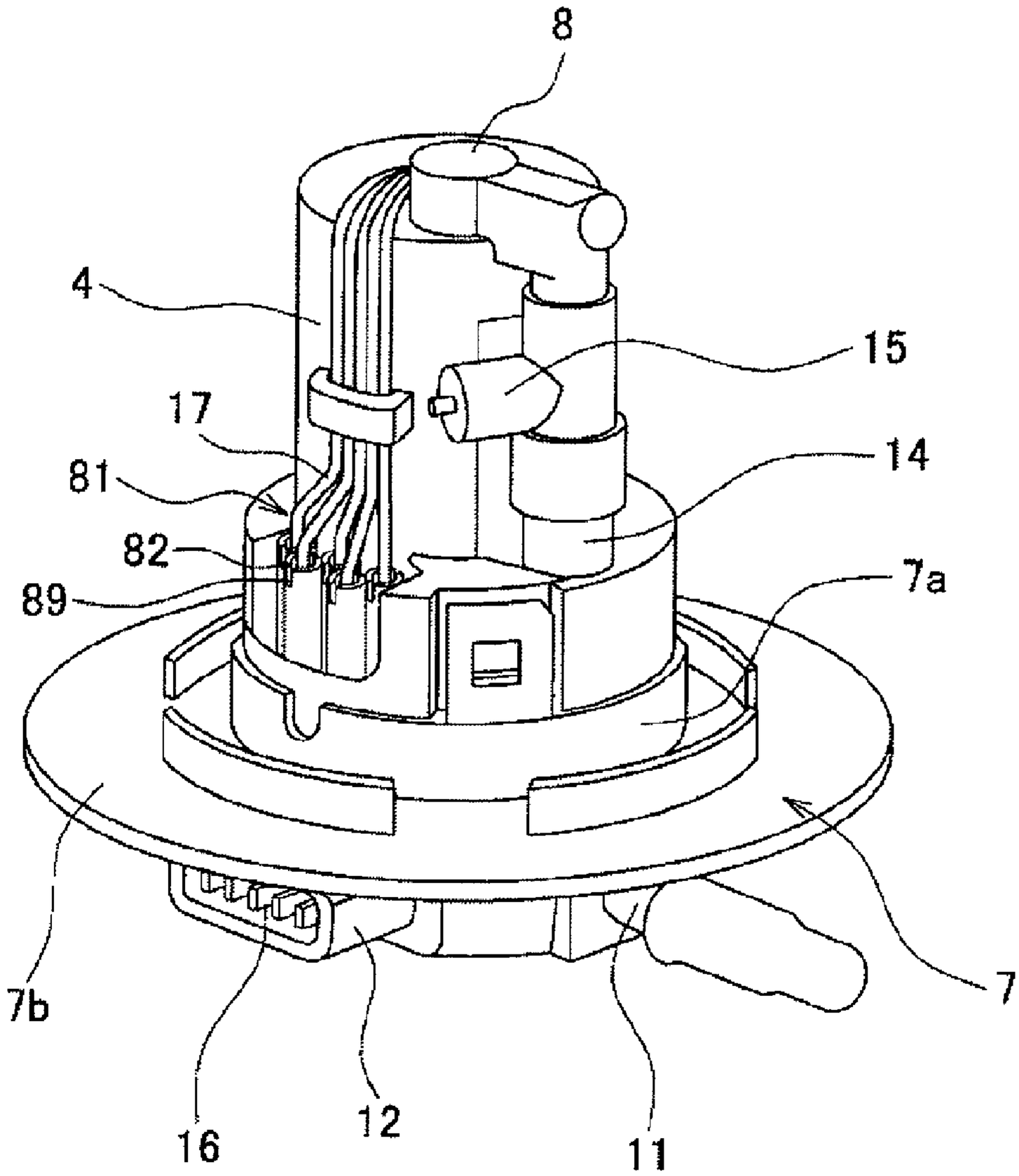

FIG. 2

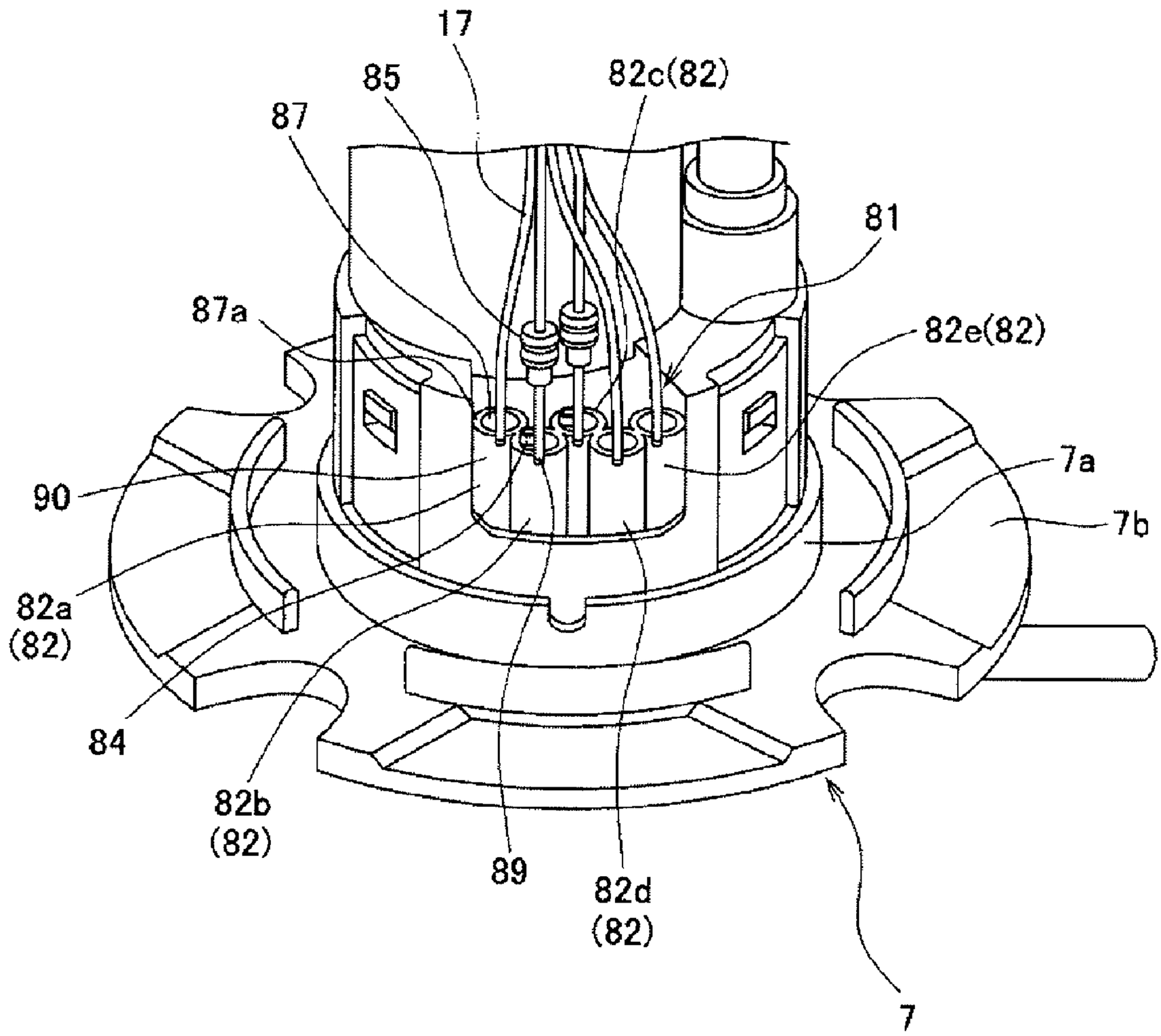

FIG. 3

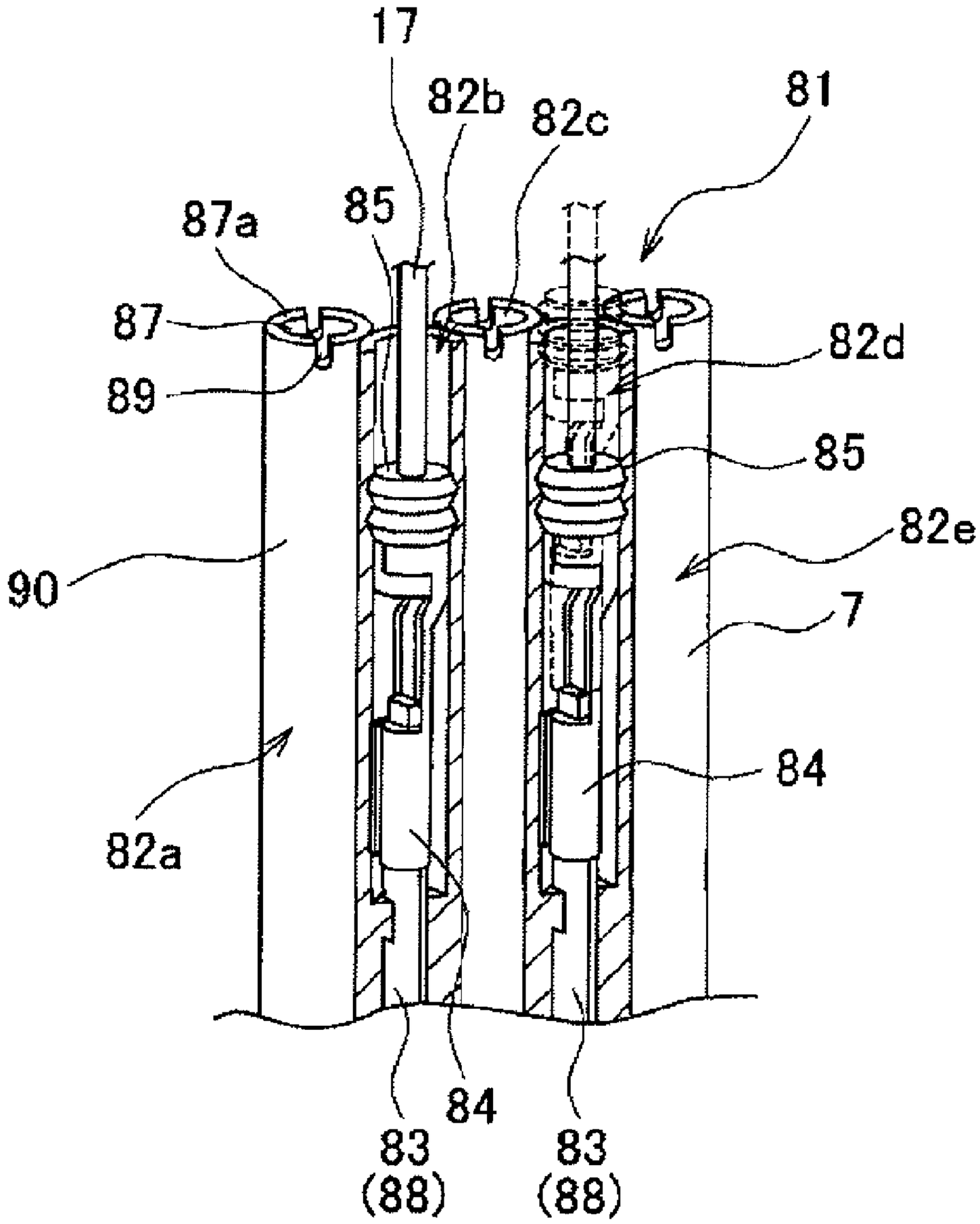

FIG. 4

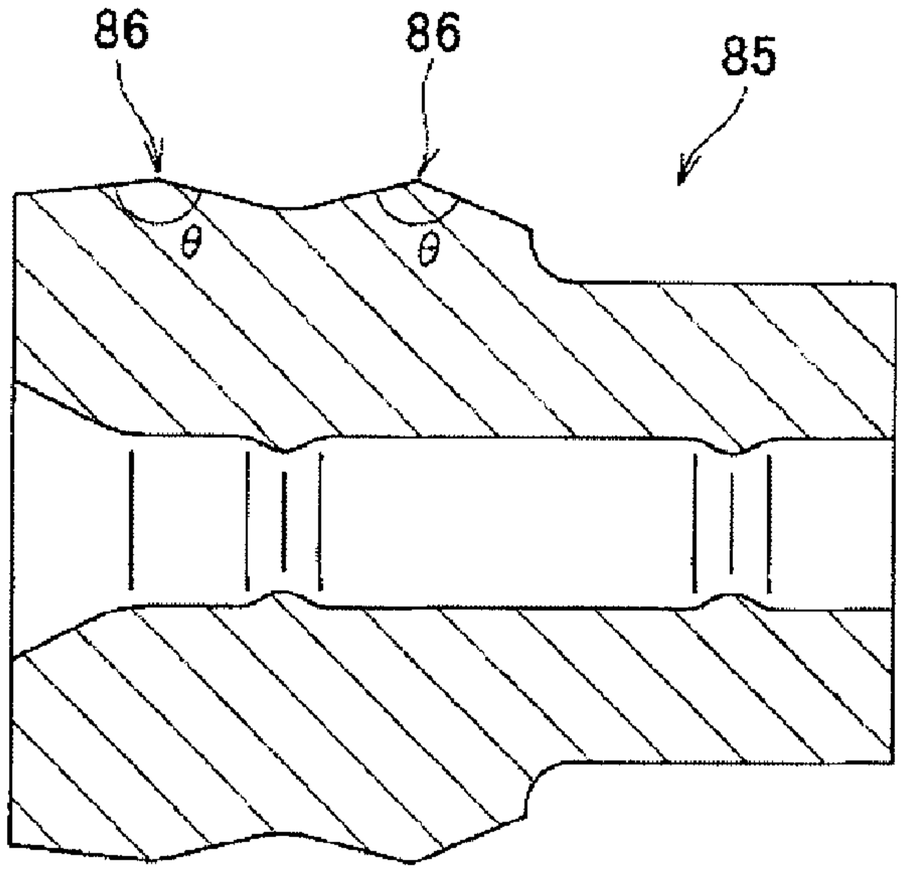

FIG. 5A

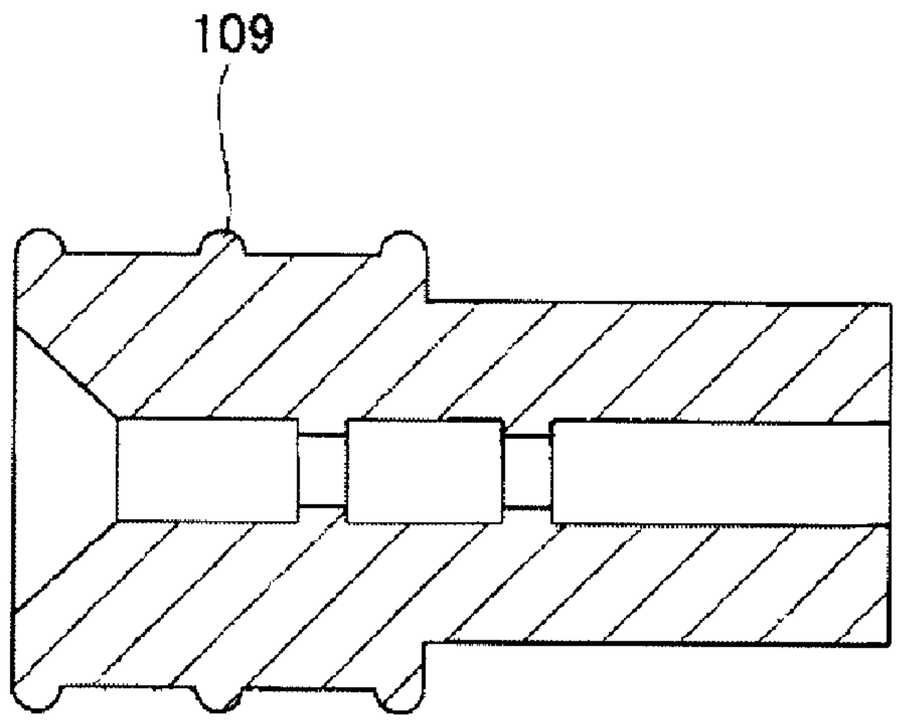

FIG. 5B

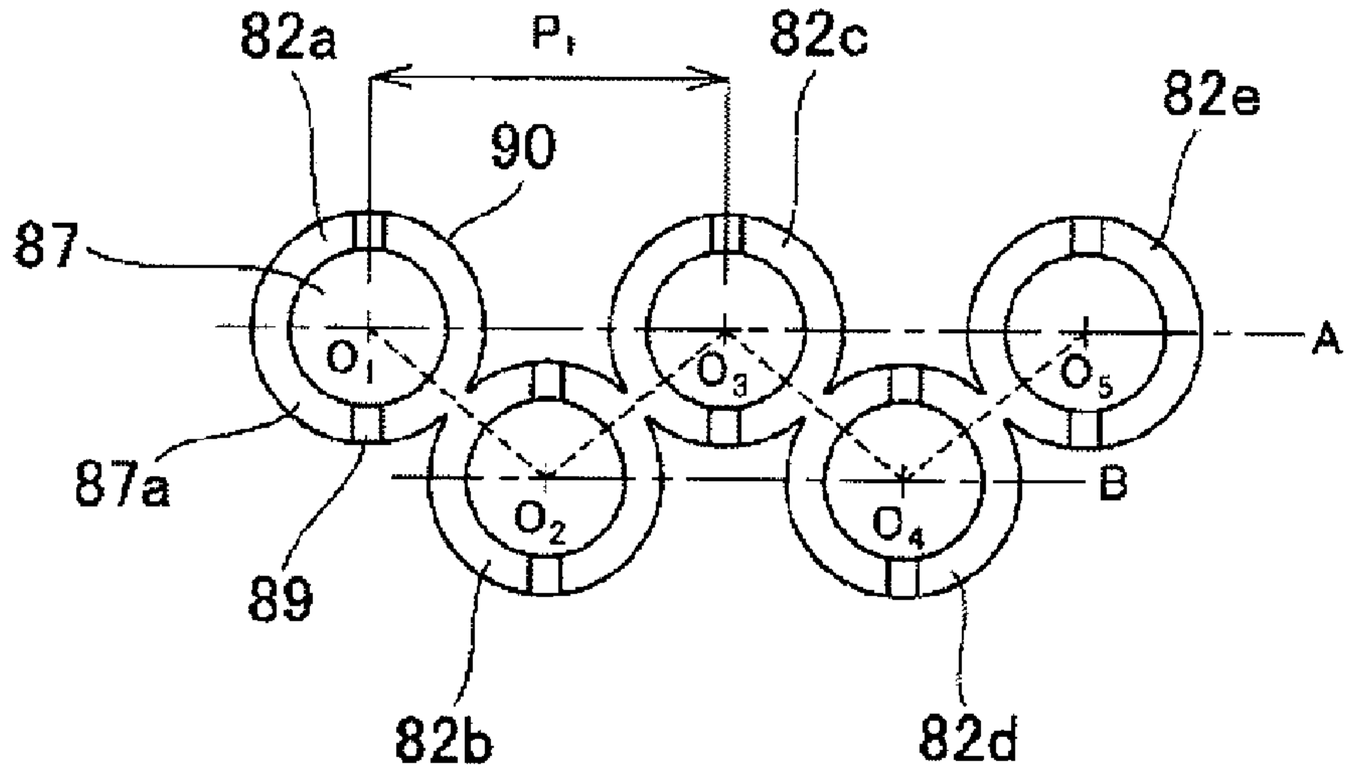

FIG. 6A

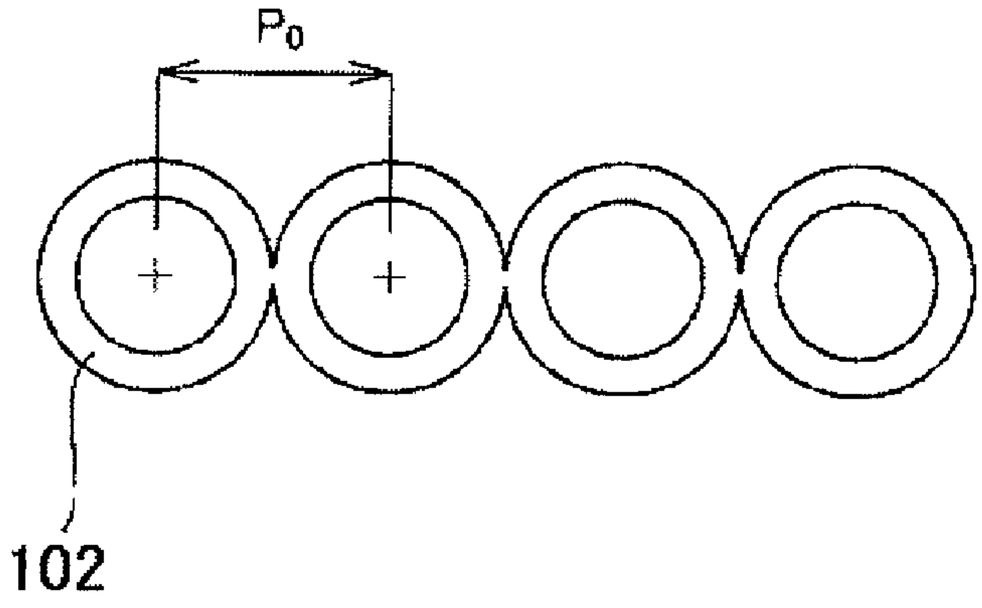

FIG. 6B

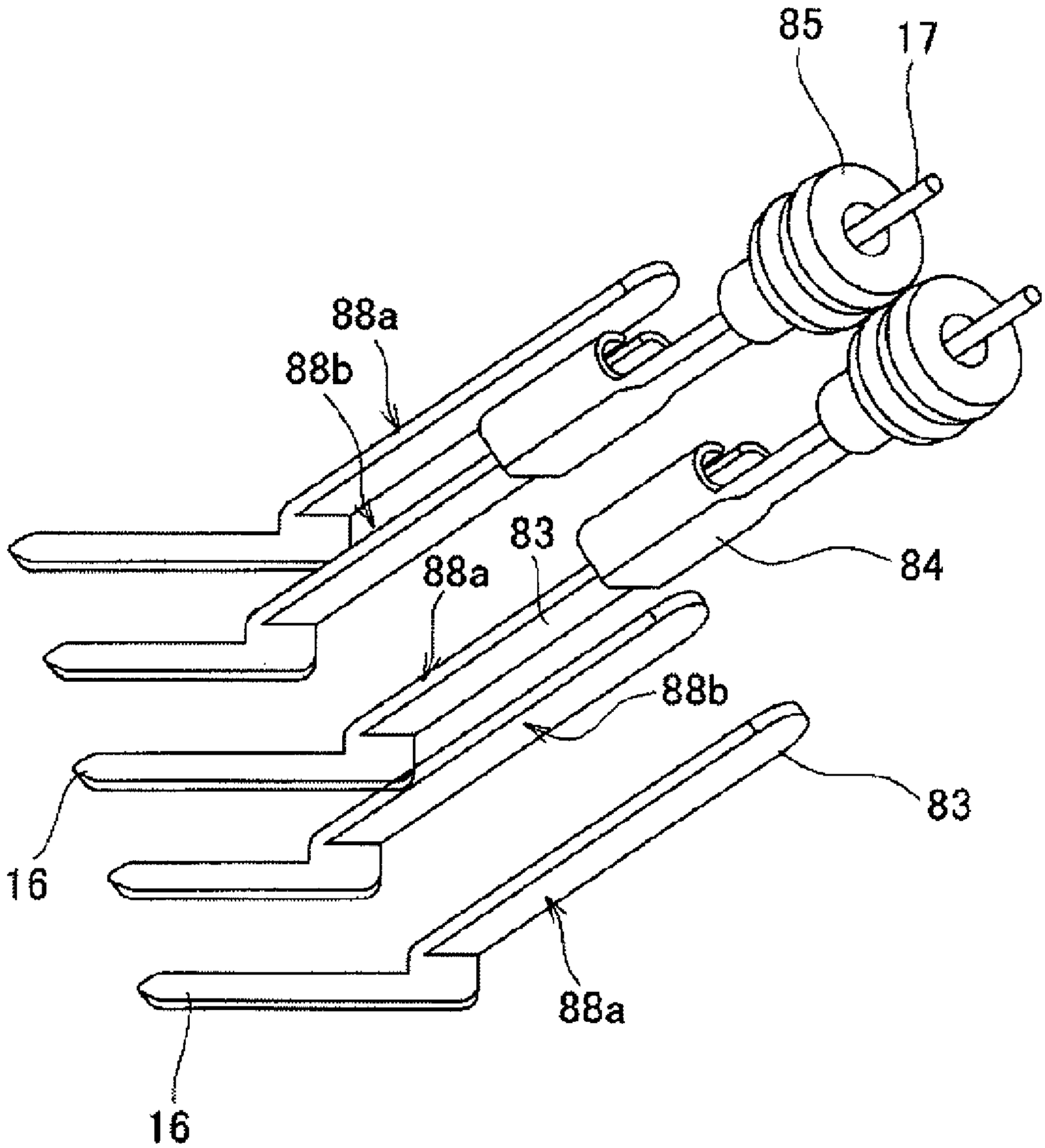

FIG. 7

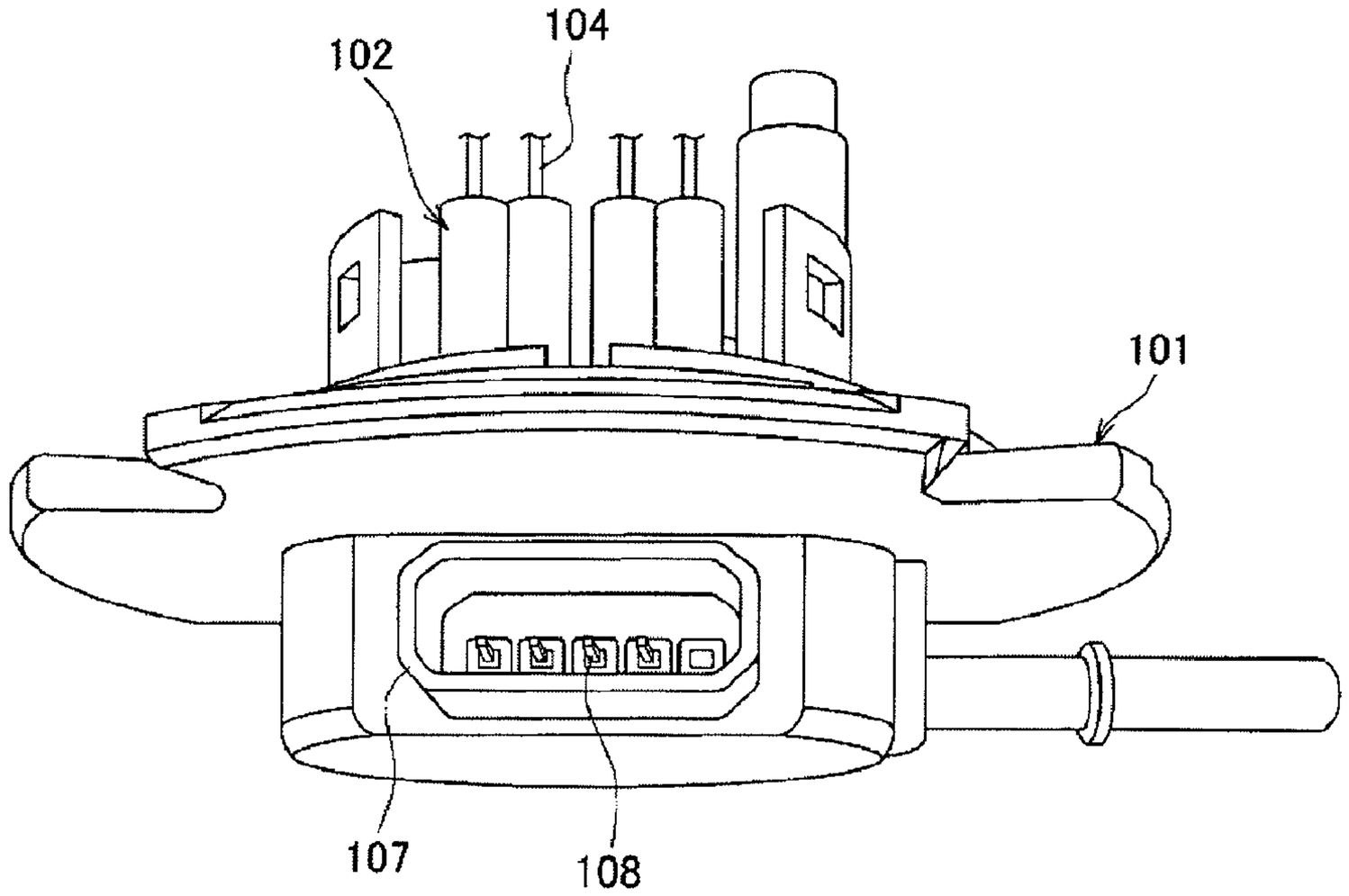

FIG. 8

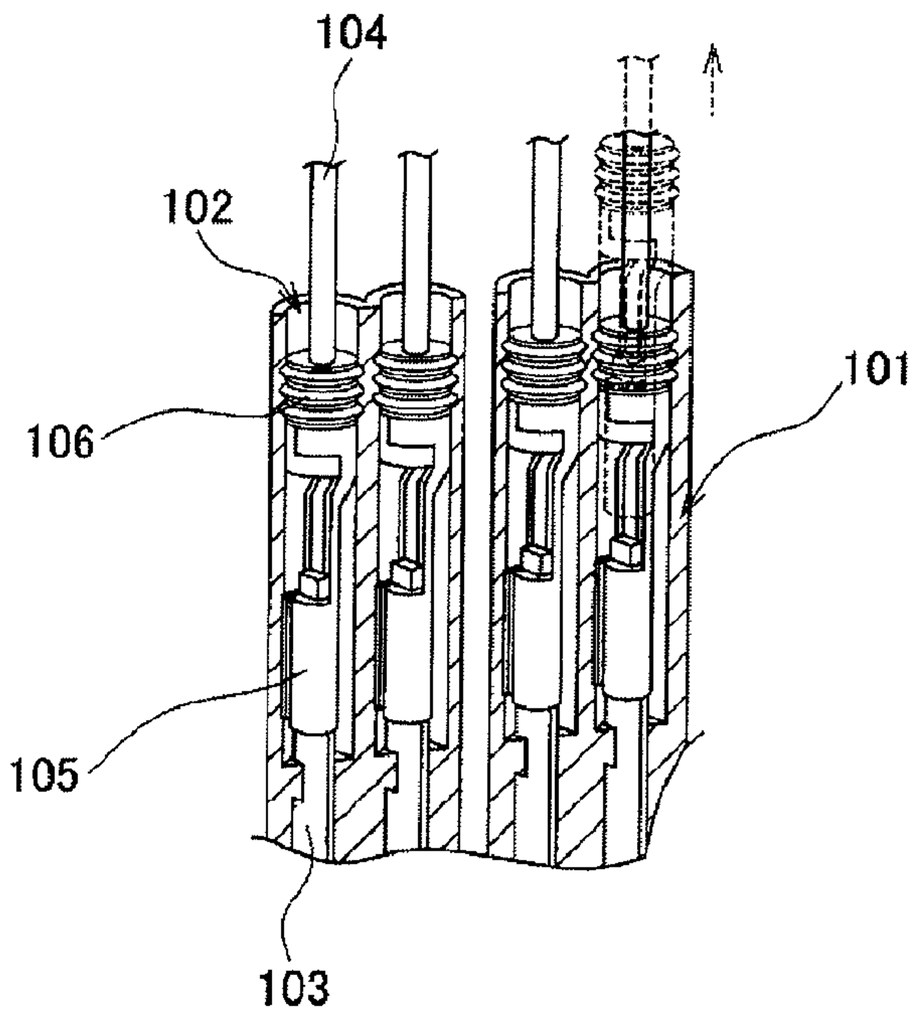

FIG. 9

FUEL SUPPLY DEVICE

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a fuel supply device for a vehicle, which uses an electric pump device, in particular, a structure of a terminal connection portion of a wiring for feeding power to a motor, in a fuel supply device for a two-wheel motor vehicle.

2. Description of the Related Art

In recent years, a fuel pump module obtained by integrating a fuel pump, a pressure controller, a strainer, and the like is widely used as a fuel supply device for vehicles such as two-wheel and four-wheel vehicles, in view of the reduction of the number of components, the improvement of efficiency of an assembly operation, and the like. In the fuel pump module, an electric pump device (hereinafter, referred to simply as an "electric pump" as needed) driven by an electric motor is used as the fuel pump. The fuel pump is unitized together with the motor for driving the fuel pump and the like to be provided in a fuel tank or in the vicinity thereof.

In the fuel supply device, the pump module is formed by fixing the electric pump, the strainer, a pressure regulator, and the like onto a disc-like member called a flange. The flange is mounted onto an opening of the fuel tank. As a result, the pump module, i.e., the fuel supply device is placed in the fuel tank. When the electric pump is driven, a fuel in the fuel tank is sucked into the fuel supply device through a filter. After being strained by the strainer and subjected to pressure control by the pressure controller or the like, the sucked fuel is supplied to a fuel supply system of an engine.

On the other hand, in the fuel supply device as described above, a wire harness for connecting power-feeding terminals provided to the flange and the pump module to each other is provided as feeder wirings for feeding electric power to the electric pump. The power-feeding terminals on the flange side are electrically connected to external supply terminals which are connected to a power supply such as an on-vehicle battery. Electric power used for driving is fed from the power-feeding terminals to the electric pump through the wire harness. Male terminals are provided inside the flange as the power-feeding terminals. The wire harness is connected to the male terminals so that female terminals provided to a fore-end of the wire harness are respectively fitted to the male terminals.

FIGS. **8** and **9** are explanatory views, each illustrating a structure of the power-feeding terminals provided on the flange side in the electric pump. As illustrated in FIG. **8**, a flange **101** includes cylindrical terminal attachment portions **102** which are formed thereon. In a bottom portion of each of the terminal attachment portions **102**, a male terminal **103** is accommodated, as illustrated in FIG. **9**. The male terminals **103** are electrically insulated from each other by the cylindrical case-like terminal attachment portions **102**. Female terminals **105** provided to a fore-end of a wire harness **104** are respectively connected to the male terminals **103**. When the female terminals **105** are respectively inserted into the terminal attachment portion **102** to be fitted to the male terminals **103** provided in the bottom portions of the terminal attachment portions **102**, the wire harness **104** is connected to a power supply.

A rubber grommet **106** is provided to each of the female terminals **105** on the wire harness **104** side. When each of the female terminals **105** is fitted to the corresponding male terminal **103** to be connected thereto, the rubber grommet **106** is inserted into the terminal attachment portion **102**. The female terminal **105** is connected to the male terminal **103** present in

the terminal attachment portion **102** while being retained by the rubber grommet **106**. The terminal attachment portion **102** is sealed by the rubber grommet **106**. A portion at which the male terminal **103** and the female terminal **105** are connected to each other is sealed by the rubber grommet **106** without being externally exposed. In a lower part of the flange **101**, a coupler attachment portion **107** is provided. One end of each of the male terminals **103** is provided as a supply terminal **108** inside the coupler attachment portion **107**. The supply terminals **108** are arranged in a row in the coupler attachment portion **107** so as to conform to the specifications of a coupler.

In the conventional fuel supply device as illustrated in FIGS. **8** and **9**, however, intervals at which the supply terminals **108** are arranged are predetermined according to the specifications of the coupler. Therefore, if the male terminals **103** are arranged according to the intervals at which the supply terminals **108** are arranged, a space for locating the terminal attachment portions **102** therein becomes small because each of the intervals between the terminals of the coupler is small. As a result, all the cylindrical terminal attachment portions **102** cannot be located in the space. On the other hand, if each of the terminal attachment portions **102** is formed to have the cylindrical case-like shape to provide partitions for sealing between the male terminals **103** as illustrated in FIG. **8**, the number of terminals which can be located in the terminal attachment portions **102** is limited. For example, even when a five-pin coupler is used, a space for only four terminals is ensured on the side of the terminal attachment portions **102**. Thus, one of the terminals of the coupler cannot be used. Moreover, one end of a metal member used for each of the supply terminals **108** is arranged according to the specifications of the coupler. On the other hand, another end of the metal member is located as the male terminal **103** in each of the terminal attachment portions **102**. Therefore, the metal member used for the terminal has a different shape for each of the terminals, and hence four metal terminal members are disadvantageously required for each device.

Further, in the case of the structure illustrated in FIGS. **8** and **9**, a distance between the terminal attachment portions **102** is reduced in response to a requirement of the reduction of size of the device or the like. If the terminal attachment portions **102** are close to each other, it becomes difficult to insert the rubber grommet **106** into the corresponding terminal attachment portion **102**. Therefore, it is difficult to connect the male terminal **103** and the female terminal **105** to each other. However, the space for locating the terminal attachment portions **102** is limited, and hence a large tapered portion cannot be formed over an opening portion of each of the terminal attachment portions **102**. In view of such problems, measures to further facilitate an operation of inserting the grommet have been requested.

SUMMARY OF THE INVENTION

The present invention has an object of efficiently arranging terminals in a limited space while ensuring sealability in a wire-harness connecting portion of a fuel supply device. The present invention has another object of improving the easiness of placement of a grommet in a sealing structure using the grommet.

A fuel supply device according to an aspect of the present invention includes: an electric pump device driven by an electric motor; and a case member for housing and retaining the electric pump device therein, and is characterized in that: the case member includes a plurality of terminal attachment portions, in which a plurality of power-feeding terminals to be

connected to feeder wirings of the electric motor are individually accommodated while being electrically insulated from each other; and the plurality of terminal attachment portions are arranged alternately in two rows so that one of the plurality of terminal attachment portions in one of the two rows is located between the terminal attachment portions which are adjacent to each other in another row.

According to the aspect of the present invention, the terminal attachment portions are arranged alternately in two rows. As a result, a larger number of the terminal attachment portions can be arranged in a space having the same length as that of a conventional space. Moreover, an interval between the terminal attachment portions which are adjacent to each other in the same row can be increased as compared with a conventional one. Therefore, it becomes easy to insert the rubber grommet provided to the feeder wiring into the terminal attachment portion. Further, the number of types of the terminal members used as the power-feeding terminals can be reduced to two.

In the fuel supply device, each of the plurality of terminal attachment portions may be formed to have a cylindrical shape so that the plurality of terminal attachment portions may respectively accommodate the plurality of power-feeding terminals therein, and a line segment obtained by connecting centers of openings of the plurality of terminal attachment portions adjacent to one another may be a polygonal line. Further, each of the plurality of power-feeding terminals may be formed by a terminal member made of a metal, having one end connected to each of the feeder wirings and another end connected to a coupler electrically connected to an external power supply. The terminal member may be configured to include two types of components including a component provided for the terminal attachment portion arranged in the one row of the plurality of terminal attachment portions arranged alternately in the two rows and a component provided for the terminal attachment portion arranged in the another row of the plurality of terminal attachment portions arranged alternately in the two rows.

At a fore-end of each of the terminal attachment portions, a slit which allows to elastically enlarge the opening of the terminal attachment portion may be provided. In this manner, when the rubber grommet provided to a portion, at which the power-feeding terminal and the feeder wiring are coupled, is to be inserted into the opening, an outer edge of the opening may be elastically enlarged owing to the slit to facilitate an operation of inserting the rubber grommet.

The rubber grommet is provided to the portion at which the power-feeding terminal and the feeder wiring are coupled, and a seal lip portion having a plurality of successively arranged concave portions and convex portions may be provided on an outer periphery of the rubber grommet. In addition, a point angle θ of each of the plurality of convex portions may be formed to be obtuse so as to easily remove the rubber grommet from a die at the time of molding. Moreover, a fluororubber having a high oil resistance may be used for the rubber grommet.

Further, the fuel supply device may be used for a fuel obtained by mixing alcohol such as ethanol and gasoline in an arbitrary proportion.

On the other hand, a fuel supply device according to another aspect of the present invention includes: an electric pump device driven by an electric motor; and a case member for housing and retaining the electric pump device therein, and is characterized in that: the case member includes a plurality of terminal attachment portions, in which a plurality of power-feeding terminals to be connected to feeder wirings of the electric motor are individually accommodated while being electrically insulated from each other; and each of the plurality of terminal attachment portions has a slit which allows to elastically enlarge an opening of each of the plurality of terminal attachment portions, at a fore-end thereof. As a result, for placing the feeder wiring in the terminal attachment portion, the insertion of the rubber grommet provided to the feeder wiring into the terminal attachment portion can be facilitated.

BRIEF DESCRIPTION OF THE DRAWINGS

In the accompanying drawings:

FIG. **1** is a sectional view illustrating a structure of a fuel supply device using an electric pump device, corresponding to an embodiment of the present invention;

FIG. **2** is a perspective view illustrating a state where a pump assembly is mounted into a flange unit and an upper cup is mounted onto the pump assembly;

FIG. **3** is an explanatory view illustrating a structure of a terminal connection portion;

FIG. **4** is an explanatory view illustrating a sectional structure of the terminal connection portion;

FIG. **5**A is a sectional view illustrating a structure of a rubber grommet used in the electric pump device illustrated in FIG. **1**, and FIG. **5**B is a sectional view illustrating a conventional rubber grommet;

FIG. **6**A is an explanatory view illustrating a state where terminal attachment portions are arranged in the fuel supply device according to the present invention, and FIG. **6**B is an explanatory view illustrating a state where the terminal attachment portions are arranged in a conventional fuel supply device;

FIG. **7** is an explanatory view illustrating structures of terminal plates;

FIG. **8** is an explanatory view illustrating a structure of a conventional terminal connection portion; and

FIG. **9** is an explanatory view illustrating a sectional structure of the conventional terminal connection portion.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Hereinafter, exemplary embodiments of the present invention are described in detail with reference to the accompanying drawings. FIG. **1** is a sectional view illustrating a structure of a fuel supply device using an electric pump device, which corresponds to an embodiment of the present invention. A fuel supply device **1** illustrated in FIG. **1** is a device for a two-wheel motor vehicle. A fuel tank **2** stores a fuel obtained by mixing alcohol and gasoline in an arbitrary proportion. The fuel supply device **1** is mounted to the fuel tank **2** by being inserted upward from a bottom of the fuel tank **2**. The fuel supply device **1** is connected to a fuel supply system (not shown) of an engine to supply the fuel to a fuel injection valve of the engine through a fuel pipe **3**.

The fuel supply device **1** includes a pump assembly (electric pump device) **6** obtained by integrating an electric motor **4**, a fuel pump (pump) **5**, and the like. The pump assembly **6** is housed in a flange unit (case member) **7**. An upper cup **8** is mounted onto the pump assembly **6** housed in the flange unit **7**. In the pump assembly **6**, the fuel pump **5** is provided on the side of one end of the electric motor **4**. On the side of another end of the electric motor **4**, an outlet cover (cover member) **24** including a pressure regulator **21** for regulating a fuel pressure and a check valve **22** for preventing a backflow of the fuel is provided.

The flange unit **7** includes a cylindrical case portion **7***a* and a flange portion **7***b*. Inside the case portion **7***a*, a filter **9** is provided. The pump assembly **6** is located above the pump assembly **6**. FIG. **2** is a perspective view illustrating a state where the pump assembly **6** is mounted into the flange unit **7** and the upper cup **8** is mounted onto the pump assembly **6**. In the state illustrated in FIG. **2**, the fuel supply device **1** is inserted into the fuel tank **2** through a pump attachment hole **2***b* which is formed through a bottom surface **2***a* of the fuel tank **2**. For mounting the fuel supply device **1** into the fuel tank **2**, the flange portion **7***b* is fixed to the bottom of the fuel tank **2** by a bolt and a nut (not shown).

An outlet pipe **11** and a power connector **12** are provided to a lower end of the flange unit **7**. The fuel pipe **3** is connected to the outlet pipe **11**. The outlet pipe **11** is connected to a fuel discharge port **13** of the pump assembly **6** through an intermediation of a communication pipe **14**. A relief valve **15** for regulating the fuel pressure in the fuel pipe **3** is provided to the communication pipe **14**. Supply terminals **16** are provided inside the power connector **12**. The supply terminals **16** are connected to a harness (a set of feeder wirings) **17** at a terminal connection portion **81**. The harness **17** extends upward on the lateral side of the pump assembly **6** to be electrically connected to the electric motor **4** at the upper end of the pump assembly **6**.

FIGS. **3** and **4** are explanatory views, each illustrating a structure of a terminal connection portion **81**. As illustrated in FIG. **3**, the flange unit **7** includes cylindrical terminal attachment portions **82** formed thereon, each extending in a vertical direction in FIG. **1**. In a bottom portion of each of the terminal attachment portions **82**, as illustrated in FIG. **4**, a male terminal (power-feeding terminal) **83** is accommodated. The male terminals **83** are electrically connected to the supply terminals **16**, respectively. For each set of the male terminal **83** and the supply terminal **16**, a terminal plate (terminal member) **88** made of a metal is used. One end of the terminal plate **88** serves as the male terminal **83**, whereas another end thereof serves as the supply terminal **16**. The male terminals **83** are respectively placed in the corresponding terminal attachment portions **82** while being electrically insulated from each other by outer walls **90** of the terminal attachment portions **82**.

On the other hand, female terminals **84** are provided at a fore-end of the harness **17**. Even in the fuel supply device **1**, the female terminals **84** are inserted into the terminal attachment portions **82** to be fitted to the male terminals **83** placed in the bottom portions of the terminal attachment portions **82**. As a result, the harness **17** is electrically connected to the supply terminals **16**. A rubber grommet **85** is provided to a portion at which each feeder wiring of the harness **17** and a corresponding one of the female terminals **84** are coupled. FIG. **5**A is a sectional view illustrating a structure of the rubber grommet **85**. As illustrated in FIG. **5**A, on an outer periphery of the rubber grommet **85**, a seal lip portion **86** having a plurality of successively arranged concave portions and convex portions is formed. When the female terminal **84** is fitted to the male terminal **83** to be connected thereto, the rubber grommet **85** is inserted into the terminal attachment portion **82** to bring the seal lip portion **86** into close contact with an inner wall of the terminal attachment portion **82**. When the rubber grommet **85** is placed in the terminal attachment portion **82**, the female terminal **84** is connected to the male terminal **83** in the terminal attachment portion **82** while being retained by the rubber grommet **85**.

Each of the convex portions of the seal lip portion **86** of the rubber grommet **85** used in the fuel supply device **1** has an obtuse point angle θ. In a water-proof coupler used in an atmosphere, nitrile butadiene rubber (NBR), silicon, or the like is conventionally used as a material of the grommet used for sealing. However, if the grommet is used in a liquid, in particular, in gasoline containing alcohol, there is a problem in that silicon greatly swells and NBR swells at a high alcohol concentration. On the other hand, if a fluororubber having an oil resistance is used as a material of the grommet, the problem of swelling does not occur. When the fluororubber is used, however, it is difficult to remove the rubber grommet at the time of molding with a conventional grommet structure having a seal lip portion **109** with projections as illustrated in FIG. **5**B. Therefore, a molding die is inevitably required to be formed as a split mold. As a result, a parting line is disadvantageously generated on a sealing surface, and hence there is a fear in that sealability may be lowered.

In view of the problem described above, in the fuel supply device **1**, each of the convex portions of the seal lip portion **86** is formed to have an obtuse point angle. In this manner, even when the fluororubber is used for the grommet, the rubber grommet **85** can be removed from (axially pulled out of) the die at the time of molding. As a result, the parting line is not generated on the sealing surface of the rubber grommet. Thus, the fluororubber having a high oil resistance can be used as the material of the rubber grommet without lowering the sealability. Moreover, the convex portion of the seal lip portion **86** is formed to have the obtuse point angle, and hence a length of a sealing area provided by the rubber grommet **85** can be increased after the rubber grommet **85** is inserted into the terminal attachment portion **82**. As a result, the reliability of sealing can be improved. An opening **87** of the terminal attachment portion **82** is closed by the rubber grommet **85** to achieve a hermetically-sealed state. The terminals **83** and **84** are sealed in the terminal attachment portion **82** in an insulated state without being externally exposed.

On the other hand, in the fuel supply device **1**, the terminal attachment portions **82** are arranged alternately in two rows, as illustrated in FIG. **3**. FIG. **6**A is an explanatory view illustrating a state where the terminal attachment portions **82** are arranged in the fuel supply device **1** according to the present invention. As illustrated in FIG. **6**A, the terminal attachment portions **82***a* to **82***e* are arranged in two rows (rows A and B). The terminal attachment portions **82** are arranged alternately in the two rows, i.e., in a zigzag manner so that one of the terminal attachment portions **82** in one of the rows is located between the terminal attachment portions **82** which are adjacent to each other in another row. Specifically, for example, the terminal attachment portion **82***b* arranged in the row B, which is adjacent to the terminal attachment portion **82***a* in the another row A, is located between the terminal attachment portions **82***a* and **82***c* adjacent to each other in the row A. Therefore, a line segment obtained by connecting respective centers O_1 to O_5 of openings of the terminal attachment portions **82***a* to **82***e* which are adjacent to one another is a polygonal line. The number of the terminal attachment portions **82** is five in this case, and hence a W-shaped line segment is created by connecting the centers O_1 to O_5. Moreover, as viewed as a whole, the openings **87** of the terminal attachment portions **82** are arranged to look like the Olympic symbol.

By arranging the terminal attachment portions **82** alternately in the two rows, a larger number of the terminal attachment portions **82** can be located in a space having the same length as that of a conventional space. Specifically, if the terminal attachment portions are arranged in one straight row as in a conventional fuel supply device illustrated in FIG. **6**B, only four terminal attachment portions can be located due to the spatial restriction. On the other hand, according to the present invention, the number of the terminal attachment

portions which can be located in the same space is increased to five as illustrated in FIG. **3**. Therefore, even when a five-pin coupler is used, there is no unavailable pin as in the case of the conventional fuel supply device. Therefore, the degree of freedom in the arrangement of the supply terminals **16** can be increased. Thus, even if there are limits in the space in which the fuel supply device is provided or the specifications of the coupler, the terminal attachment portions **82** can be designed in accordance with the coupler without impairing the sealing functions and insulating performance of the portion at which the terminals are connected to the harness **17**.

Moreover, an interval between the terminal attachment portions **82** which are adjacent to each other in the same row (distance between the centers O of the openings) can also be increased as compared with a conventional interval (conventional interval P_0, and interval P_1 in the present invention; see FIGS. **6**A and **6**B). Therefore, the operability of the operation of inserting the grommet can be improved while the requirement of the reduction of the size of the device is satisfied. In the fuel supply device **1**, slits **89** are provided at the fore-end of each of the terminal attachment portions **82**. Owing to the slits **89**, an outer edge **87***a* of the opening **87** can be elastically enlarged when the rubber grommet **85** is inserted into the terminal attachment portion **82**. The elastically enlarged outer edge **87***a* of the opening **87** further facilitates the operation of inserting the grommet as compared with that in the conventional device. In addition to the effects of the increased interval between the centers of the openings, the operability in the placement of the grommet is greatly improved in the fuel supply device **1**.

Further, the number of types of the terminal plates **88** can be reduced to two in the fuel supply device **1** of the present invention. FIG. **7** is an explanatory view illustrating structures of the terminal plates **88**. As described above, four types of components are required as the terminal plates in the conventional fuel supply device. Thus, the conventional fuel supply device is disadvantageous in the increased number of components and the lowered operability in the placement. In the fuel supply device **1** of the present invention, the number of types of the components can be reduced to two, that is, terminal plates **88***a* (three in number) respectively corresponding to the terminal attachment portions **82***a*, **82***c*, and **82***e* in the row on the rear side and terminal plates **88***b* (two in number) respectively corresponding to the terminal attachment portions **82***b* and **82***d* in the row on the front side. Thus, as compared with the conventional fuel supply device, the number of components can be reduced to reduce product cost. Further, the operability at the time of placement is improved. As a result, the number of fabrication steps is reduced to reduce erroneous placement.

In the flange unit **7**, a bottom portion of the case portion **7***a* serves as a reservoir portion **71**. The reservoir portion **71** is placed below the bottom surface **2***a* of the fuel tank **2**. A fuel inlet hole **72** is formed on a side surface of the upper cup **8**. The fuel flows through the fuel inlet hole **72** into the reservoir portion **71**. The filter **9**, which is folded in the middle, is provided in the reservoir portion **71**. The fuel flowing to be stored in the reservoir portion **71** is sucked by the fuel pump **5** through the filter **9**.

The pump assembly **6** includes the electric motor **4**, the fuel pump **5**, the pressure regulator **21**, and the check valve **22**, which are integrally housed within a shell case **23** made of steel. The outlet cover **24** and an inlet cover **25** are respectively fixed to the ends of the cylindrical shell case **23** by caulking. The outlet cover **24** is made of a synthetic resin and is mounted to one end of the shell case **23**.

A brush holder portion **27** for holding a brush **26** of the electric motor **4** is provided to the outlet cover **24**. Specifically, the outlet cover **24** serves as a cover of the shell case **23** and also as the brush holder of the electric motor **4**. The pressure regulator **21** and the check valve **22** are provided inside the outlet cover **24**. The check valve **22** is provided to the fuel discharge port **13**. An end of the check valve **22** is connected to the communication pipe **14** in communication therewith. An end of the pressure regulator **21** is open in the fuel tank **2**.

The inlet cover **25** is formed by die-casting of aluminum and is mounted to another end side of the shell case **23**. A fuel inlet portion **28** is provided in a projecting manner on the lowed end side of the inlet cover **25**. The filter **9** is provided to the outer side of the fuel inlet portion **28**. The filter **9** is formed to have an approximately rectangular shape as a whole. The filter **9** is provided in the case portion **7***a* of the flange unit **7** while being folded in a C-like shape.

The electric motor **4** is a DC motor with a brush. The shell case **23** also serves as a yoke of the electric motor **4**. A plurality of permanent magnets **31** are fixed onto an inner circumferential surface of the shell case **23**. An armature **32** is rotatably provided on the inner side of the permanent magnets **31**. The armature **32** includes: a core **34** including a plurality of axially extending slots **33**; and a winding **35** wound around the core **34** so as to pass along the slots **33**. The armature **32** is fixed to a rotating shaft **36**. The armature **32** is rotatably supported between a bearing portion **37** provided to the outlet cover **24** and a bearing **38** provided to a pump case **61**. Above the armature **32** in FIG. **1**, a commutator **40** is provided. The commutator **40** is fixed to the rotating shaft **36**. The brush **26** is in abutment against the commutator **40** in a radial direction.

The pressure regulator **21** includes: an armature **43** including a ball (steel ball) **42**; and a valve spring **44**. The armature **43** and the valve spring **44** are accommodated in a regulator accommodating portion **41** formed inside the outlet cover **24**. The regulator accommodating portion **41** has a minor-diameter portion **45** on the upstream side (lower side in FIG. **1**) and a major-diameter portion **46** on the downstream side. A valve surface is formed at the boundary between the minor-diameter portion **45** and the major-diameter portion **46**. The valve surface is obtained by plastically deforming an edge of the boundary portion between the minor-diameter portion **45** and the major-diameter portion **46** with punching. When the ball **42** comes into close contact with the valve surface, the pressure regulator **21** is placed in a valve-closed state. A retainer **47** is pressed into and fixed to an end of the major-diameter portion **46** on the downstream side. The retainer **47** is formed to have an approximately ring-like shape. One end of the valve spring **44** is in abutment against the upstream side (lower end surface) of the retainer **47**.

A coil spring is used as the valve spring **44**. Another end of the valve spring **44** is in abutment against a spring holder **48** of the armature **43**. The ball **42** is normally in pressure contact with the valve surface by a biasing force of the valve spring **44** (valve-closed state). When a fluid pressure is applied from the minor-diameter portion **45** side to become larger than the biasing force of the valve spring **44**, the ball **42** is moved upward to generate a gap between the valve surface and the ball **42**. As a result, the pressure regulator **21** is placed in a valve-open state. Specifically, when a fuel pressure in the shell case **23** exceeds a predetermined regulating pressure, the fuel pressure is applied to the armature **43** to move upward the armature **43**. As a result, an excessive fuel is returned to the fuel tank **2**. When the fluid pressure is lowered and the biasing force of the valve spring **44** becomes larger than the fluid pressure, the ball **42** is moved downward by the biasing

force of the valve spring **44** to come into abutment against the valve surface. When the ball **42** abuts against the valve surface, the minor-diameter portion **45** is closed. As a result, the pressure regulator **21** is placed in the valve-closed state.

The check valve **22** includes: a valve **53** having a semispherical sealing portion **52** at one end; and a valve spring **54**. The valve **53** and the valve spring **54** are accommodated in a check valve accommodating portion **51** formed inside the outlet cover **24**. Similarly to the regulator accommodating portion **41**, the check valve accommodating portion **51** includes a minor-diameter portion **55** on the upstream side and a major-diameter portion **56** on the downstream side. A tapered surface **57** is formed in a boundary portion between the minor-diameter portion **55** and the major-diameter portion **56**. When the sealing portion **52** comes into abutment against the tapered surface **57**, the check valve **22** is placed in a valve-closed state. A valve guide **58** is fixed by caulking to an end of the major-diameter portion **56** on the downstream side. One end of the valve spring **54** is in abutment against the upstream side (lower end surface) of the valve guide **58**.

A coil spring is used even for the valve spring **54**. Another end of the valve spring **54** is in abutment against the valve **53**. The sealing portion **52** of the valve **53** is normally in pressure contact with the tapered surface **57** by the biasing force of the valve spring **54** (valve-closed state). When the fluid pressure is applied from the minor-diameter portion **55** side to become larger than the biasing force of the valve spring **54**, the valve **53** is moved upward to generate a gap between the tapered surface **57** and the sealing portion **52**. As a result, the check valve **22** is placed in a valve-open state. When the fuel pump **5** is operated to cause the fuel to be supplied from the minor-diameter portion **55** side, the check valve **22** is opened by the pressure of the fuel to supply the fuel to the fuel pipe **3**. When the fuel pump **5** is stopped to lower the fluid pressure, the biasing force of the valve spring **54** becomes larger than the fluid pressure. As a result, the valve **53** is moved downward by the biasing force of the valve spring **54**. When the valve **53** is moved downward, the sealing portion **52** comes into abutment against the tapered surface **57** to close the minor-diameter portion **55**. As a result, the check valve **22** is placed in the valve-closed state. When the check valve **22** is closed, the fuel can be prevented from reversely flowing from the fuel pipe **3** to the fuel pump **5**.

The fuel pump **5** is a non-positive displacement type regenerative pump and includes the pump case **61** and an impeller **62**. On the lower end side of the pump case **61**, a cylindrical impeller accommodating portion **63** is provided in a concave manner. The impeller **62** connected to the rotating shaft **36** of the electric motor **4** is provided in the impeller accommodating portion **63**. A D-shaped portion **36***a* is formed on the rotating shaft **36**. The impeller **62** is mounted to the D-shaped portion **36***a* to rotate integrally with the rotating shaft **36**. In an area of the impeller **62** on the side closer to the outer periphery thereof, a plurality of pump chambers **64** are provided along a circumferential direction.

The fuel inlet portion **28** is provided to the inlet cover **25** so as to correspond to the pump chambers **64**. As described above, in a pre-stage of the fuel inlet portion **28**, the filter **9** is located. A communication hole **65** is provided on the upper end side of the impeller accommodating portion **63** so as to correspond to the pump chambers **64**. The communication hole **65** is open in the shell case **23** to be faced thereto. When the electric motor **4** is driven to operate the rotating shaft **36**, the impeller **62** is rotated in the fuel pump **5**. With the rotation of the impeller **62**, the fuel is sucked into the pump chambers **64** from the fuel inlet portion **28**. The fuel supplied to the pump chambers **64** is delivered through the communication hole **65** into the shell case **23** by the rotation of the impeller **62**. The fuel in the shell case **23** is supplied to the fuel pipe **3** through the check valve **22**.

The fuel supply device **1** functions as follows. First, when the electric motor **4** is driven to operate the fuel pump **5**, the fuel in the fuel tank **2** passes through the fuel inlet hole **72** to flow into the reservoir portion **71**. The fuel in the reservoir portion **71** is sucked into the fuel inlet portion **28** through the filter **9**. In the fuel pump **5**, the impeller **62** rotates with the rotating shaft **36**. With the rotation of the impeller **62**, the fuel is sucked from the fuel inlet portion **28** into the pump chambers **64**. The fuel supplied to the pump chambers **64** is delivered to the shell case **23** by the rotation of the impeller **62**. The fuel in the shell case **23** is supplied from the fuel discharge port **13** to the fuel pipe **3** through the check valve **22**.

When the fuel pressure exceeds the predetermined regulating pressure along with the pumping operation, the pressure regulator **21** is placed in the valve-open state. When the pressure regulator **21** is opened, the fuel in the shell case **23** is returned to the fuel tank **2**. As a result, the pressure of the fuel supplied to the fuel pipe **3** side is appropriately regulated. As described above, the fuel pipe **3** is connected to the fuel injection valve of the engine. The fuel sucked from the fuel tank **2** by the fuel supply device **1** is supplied to the fuel injection valve through the fuel pipe **3**.

It is apparent that the present invention is not limited to the embodiments described above and various changes are possible without departing from the scope of the present invention.

In the above-mentioned embodiment, the fuel supply device used for the fuel obtained by mixing alcohol and gasoline in an arbitrary proportion has been described. However, the present invention is also applicable to a fuel supply device used only for gasoline. Moreover, the number of terminals (five in this embodiment) in the terminal connection portion **81** is merely an example, and therefore, the number of terminals is not particularly limited. Further, the relation of the male terminals and the female terminals is not limited to that described above. The male terminals may be provided on the harness **17** side, whereas the female terminals may be provided on the side of the terminal attachment portions **82**.

On the other hand, although the example where the fuel supply device according to the present invention is used for the two-wheel motor vehicles has been described in the above-mentioned embodiments, the use of the fuel supply device according to the present invention is not limited thereto. The fuel supply device according to the present invention can also be used as a fuel supply device for various vehicles such as four-wheel motor vehicles. Moreover, the structure of the present invention is applicable not only to the fuel pump but also to a pump which supplies a liquid such as water or a chemical liquid or a gas such as air. Further, the structures of the electric motor **4** and the fuel pump **5** are not particularly limited. For example, the number of poles, the number of slots, the shape of the impeller, and the like can be appropriately set.

What is claimed is:

1. A fuel supply device, comprising:

an electric pump device configured to be driven by an electric motor; and

a case member for housing and retaining the electric pump device therein, wherein:

the case member comprises a plurality of terminal attachment portions, in which a plurality of power-feeding terminals to be connected to feeder wirings of the electric motor are individually accommodated while being electrically insulated from each other; and

the plurality of terminal attachment portions are arranged alternately in two rows so that one of the plurality of terminal attachment portions in one of the two rows is located between the terminal attachment portions which are adjacent to each other in another row.

2. A fuel supply device according to claim **1**, wherein:

each of the plurality of terminal attachment portions is formed to have a cylindrical shape so that the plurality of terminal attachment portions may respectively accommodate the plurality of power-feeding terminals therein; and

a line segment obtained by connecting centers of openings of the plurality of terminal attachment portions adjacent to one another is a polygonal line.

3. A fuel supply device according to claim **1**, wherein:

each of the plurality of power-feeding terminals is formed by a terminal member made of a metal;

the terminal member has one end which is connected to each of the feeder wirings and another end which is connected to a coupler electrically connected to an external power supply; and

the terminal member includes two types of components including a component provided for the terminal attachment portion arranged in the one row of the plurality of terminal attachment portions arranged alternately in the two rows and a component provided for the terminal attachment portion arranged in the another row of the plurality of terminal attachment portions arranged alternately in the two rows.

4. A fuel supply device according to claim **2**, wherein:

each of the plurality of power-feeding terminals is formed by a terminal member made of a metal;

the terminal member has one end which is connected to each of the feeder wirings and another end which is connected to a coupler electrically connected to an external power supply; and

the terminal member includes two types of components including a component provided for the terminal attachment portion arranged in the one row of the plurality of terminal attachment portions arranged alternately in the two rows and a component provided for the terminal attachment portion arranged in the another row of the plurality of terminal attachment portions arranged alternately in the two rows.

5. A fuel supply device according to claim **1**, wherein:

each of the plurality of terminal attachment portions is provided with a slit which allows an opening of each of the plurality of terminal attachment portions to be elastically enlarged, at a fore-end thereof; and

an outer edge of the opening is elastically enlarged owing to the slit when a rubber grommet provided to a portion at which each of the plurality of power-feeding terminals and the corresponding one of the feeder wirings are coupled is inserted through the opening.

6. A fuel supply device according to claim **1**, wherein:

a portion at which each of the plurality of power-feeding terminals and the corresponding one of the feeder wirings are coupled is provided with a rubber grommet; and

the rubber grommet includes a seal lip portion having a plurality of concave portions and a plurality of convex portions which are successively arranged on an outer periphery thereof, while a point angle θ of each of the plurality of convex portions is formed to be obtuse.

7. A fuel supply device according to claim **6**, wherein the rubber grommet is formed of a fluororubber.

8. A fuel supply device according to claim **1**, wherein the fuel supply device is used for a fuel obtained by mixing alcohol and gasoline in an arbitrary proportion.

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